Claim

1. A projected moiré fringe 3-D surface shape measuring device the characteristics of device are that the said device includes a projection device with mark point and main grating, and an observation device with mark point and sub-grating, as well as two coordinate rectilinear motion axes which form a right triangle consists of the mark point of projection device in the imaging position, the mark point of observation device, and the mark point projected on object surface by projection device.

2. The said projected moiré fringe 3-D surface shape measuring device in Claim 1. It has characteristics that two coordinate rectilinear motion axes of the said right angle measuring triangle include No.1 rectilinear motion axis with grating ruler that coincided with the observation device optical axis, and No.2 rectilinear motion axis with grating ruler that is vertical to the observation device optical axis. The projection device optical axis and No.2 rectilinear motion axis with grating ruler that is vertical to the observation device optical axis are crossed as a γ angle. The projection device optical axis and the observation device optical axis are crossed as a θ angle. The sum of γ angle and θ angle is 90 degrees.

3. The said projected moiré fringe 3-D surface shape-measuring device in Claim 1 or 2. It has characteristics that the said measuring device includes an image capturing board that digitalized the image signals and a computer used for processing digital images.

4. The said projected moiré fringe 3-D surface shape measuring device in Claim 1 or 2. It has characteristics that the said projection device includes light source, main grating, mark point and mobile projection device imaging lens.

5. The said projected moiré fringe 3-D surface shape-measuring device in Claim 4. It has characteristics that the said mark point is behind or parallel with the main grating.

6. The said projected moiré fringe 3-D surface shape-measuring device in Claim 1 or 2. It has characteristics that the said observation device includes a measuring beam path. The said measuring beam path includes camera, sub-grating, mark point parallel

with sub-grating that can splice into the beam path, and mobile observer-imaging lens.

7. The said projected moiré fringe 3-D surface shape measuring device in Claim 1 or 2. It has characteristics that the said observation device includes measuring beam path and observation beam path; the said measuring beam path includes camera, sub-grating, mobile observer imaging lens; the observation beam path includes camera used for receiving mark point image, reflector used for turning the light direction by 90 degrees, mark point, and square prism behind observer imaging lens and before sub-grating, used for turning the light direction by 90 degrees.

8. The said projected moiré fringe 3-D surface shape measuring device in any one of Claim 4, 5, 6, 7 has characteristics that the said main grating and sub-grating are square wave or sine wave, the mark point is cross wire or ring.

9. The said projected moiré fringe 3-D surface shape measuring device in any one of Claim 4, 5, 6, 7 has characteristics that the said light source gives off white light.

10. The said projected moiré fringe 3-D surface shape measuring device in any one of Claim 4, 6, 7 has characteristics that the mobile projective lens in said projection device includes projective lens, linear positioner moving the projective lens; the mobile observer imaging lens in observation device includes observer imaging lens and linear positioner moving the observer imaging lens.

11. The said projected moiré fringe 3-D surface shape measuring device in Claim 1. It has characteristics that the said device is composed of observation device, No.1 rectilinear motion axis and the first grating ruler in the direction of observation device optical axis, rotary stage installed on No.1 rectilinear motion axis slide used for under propping the measured object, No.2 rectilinear motion axis and the second grating ruler vertical to No.1 rectilinear motion axis, projection device with optical axis crossed as γ angle with No.2 rectilinear motion axis, platform used for positioning No.1 rectilinear motion axis, the first grating ruler, No.2 rectilinear motion axis and the second grating ruler, and for placing the said instruments, image capturing board used for digitalizing images, and computer used for processing digital images. The projection device optical axis and observation device optical axis said in above parts are crossed as θ angle.

12. The said projected moiré fringe 3-D surface shape measuring device in Claim 11. It has characteristics that the said projection device includes light source before condenser, and main grating and projective lens before or parallel with mark point. The move of main grating in the grating surface is controlled by linear positioner. The move of projective lens 15 in the direction of optical axis is controlled by linear positioner.

13. The said projected moiré fringe 3-D surface shape-measuring device in Claim 11. It has characteristics that the said observation device 20 includes measuring beam path. The measuring beam path includes camera21 and camera imaging lens22 that are used for receiving the moiré fringe and mark point on the sub-grating surface, sub-grating mark point switch 23, and mobile imaging lens29. The move of imaging lens29 in the optical axis direction is controlled by linear positioner 29A.

14. The said projected moiré fringe 3-D surface shape-measuring device in Claim 11. It has characteristics that the said observation device 20 also includes observation beam path. The said observation beam path includes camera imaging lens27 and camera28 that are used for receiving the image of mark point25, and reflector 26 used for turning the light direction by 90 degrees. Measuring beam path and observation beam path are vertical to each other, the direction turning of which is achieved by square prism 24 that is behind imaging lens29 and before sub-grating23. The move of observation lens 29 in the optical axis direction is controlled by linear positioner 29A.

15. The said projected moiré fringe 3-D surface shape-measuring device in Claim 1. It has characteristics that the said method involves the following steps:

(1) Form a right triangle consists of the mark point of projection device, the mark point of the observation device, and the mark point projected on object surface by projection device;

(2) Determine the projected conjugate distance and observed conjugate distance;

(3) Work out the projected object distance, image distance as well as the observed object distance and image distance;

(4) Automatically focus on the projective lens and the observation lens according to the projected object distance and image distance, as well as the observed object

distance and image distance. Form the moiré fringe on the sub-grating surface of observation device.

(5) Determine the phase distribution applying mark point projected on the object as the zero phase according to the phase-shift algorithm and unwrapping algorithm.

(6) Calculate the height distribution.

16. The measuring method said in Claim 15. It has characteristics that the formation of the said right triangle includes the following procedures: Move the object to whole- field of observation device, and focus the mark point projected on the object, then align mark point projected on the object with mark point of observation device.

17. The measuring method said in Claim 15. It has characteristics that the procedures for determining the projected conjugate distance and observed conjugate distance are as follows: Work out the other two edges by one edge of the right triangle, i.e. $AE=AD/tg\theta; DE=AD/sin\theta$, the θ in which is the angle between projection device and optical axis of observation device, $\theta=arctgR_2/R_1$ and AD is the distance between projection device and observation device measured by grating ruler; R_1 and R_2 are separately the move amount of grating, the observed conjugate distance AE is the distance between observation device sub-grating and the object, and the projected conjugate distance DE is the distance between projection device main grating and the object.

18. The measuring method said in Claim 15. It has characteristics of working out the projected image distance and object distance, and the observed image distance and object distance by the following equations:

$$Z_C + Z_{CF} = \frac{AD}{tg\vartheta} \qquad \frac{1}{Z_C} + \frac{1}{Z_{CF}} = \frac{1}{F_1}$$

$$L_p + L_{PF} = \frac{AD}{sin\vartheta} \qquad \frac{1}{L_P} + \frac{1}{L_{PF}} = \frac{1}{F_2}$$

Where, Z_C represents the observed object distance, and Z_{CF} represents observed image distance; and L_{PF} represents projected image distance, and L_P represents the projected object distance, and F_1 represents the focal length of observation lens, and F_2 represents the focal length of projective lens.

19. The said measuring method in Claim 15. It has characteristics that forming a moiré fringe on the sub-grating surface of observation device by moving projective lens and observation lens according to the projected object distance and the projected image distance, and the observed object distance and the projected image distance.

20. The said calculation method for height distribution by formulae in Claim15 is characterized by the following formulae:

$$Z = -\frac{(\frac{\varphi}{2\pi f} + X_C)D - L_{PF}B}{(\frac{\varphi}{2\pi f} + X_C)C - L_{PF}A}$$

$$X_Z = \frac{Z + Z_C}{Z_{CF}} X_C$$

$$Y_Z = \frac{Z + Z_C}{Z_{CF}} Y_C$$

Where, X_Z, Y_Z, Z are position coordinates of the object at a certain position respectively; and

$$A = Z_C Z_{CF} \sin\theta + Z_C X_C \cos\theta \qquad B = Z_C^2 X_C \cos\theta$$

$$C = Z_C Z_{CF} \cos\theta - Z_C X_C \sin\theta \qquad D = -Z_C^2 X_C \sin\theta + Z_C Z_{CF} L_P;$$

Where, if represents the grating frequency; Z_C represents the observed object distance, and Z_{CF} represents observed image distance; and L_{PF} represents projected image distance, and L_P represents the projected object distance; and θ represents the included angle formed by the projection device's optical axis and the observation device's optical axis.